Space Weather Technical Forecast

Issued on Wednesday, 23 August 2023 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing chance of M-flares (R1-R2 Radio Blackouts). Slight chance G1 Minor Storms late day 1 or day 2 (23-24 Aug).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with the peak flare of M1.1 at 22/2304 UTC from the AR3405 region in the western disk. There are currently seven numbered regions on the visible disk. The majority are simple and mature unipolar or bipolar spots with little development. However, AR3415 on the southeast limb, along with the simpler, but moderately sized AR3413 provide some increased flare risk. AR3415 is a modestly sized, compact and potentially complex region but is still at too oblique an angle for a confident analysis. AR3413 has seen some development of small spots to the north of its dominant leader.

A large coronal dimming was observed alongside the M1.1 flare, however no associated CME has been identified. A subsequent filament eruption to the southeast also occurred, however this is still under analysis. No other potentially Earth-directed CMEs were identified.

Solar Wind / Geomagnetic Activity: Solar wind speeds measured by ACE and DSCOVR at L1 persisted at slightly elevated levels, at around 400-450km/s. Density was near average. Total Interplanetary Magnetic Field (IMF) Bt, was weak, generally below 5nT, with the north-south component, Bz, also weakly varying between -4 and 4nT, but predominately positive (northward). Phi angle was mainly negative (Towards the Sun). Geomagnetic activity was Quiet (Kp0-1).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background. GOES16 high energy (greater than 2MeV) electron flux ranged from Background to Moderate. The associated 24-hour fluence was well below the Active level, with an observed value of 8.7e6 integrated pfu at 23/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be generally Low, but with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs, however the filament eruption from 23 Aug is still under analysis. Current slightly elevated winds are likely to become enhanced later day 1 or day 2 (23-24) due to the arrival of any fast wind associated with CH39/+, potentially rising to around 500-550km/s. Mainly Quiet geomagnetic activity is expected at first, with isolated Unsettled spells. This increasing to Unsettled to Active later day 1 or day 2 (23-24 Aug), with a chance of isolated G1 Minor Storms. Activity is then expected to ease back to mostly Quiet to Unsettled day 3-4 (25-26 Aug). There is a slight chance of this rising again to Unsettled to Active from any further HSS arrival later day 4 from CH38/-.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) will vary from Background to Moderate day 1 (23 Aug) before a subsequent drop out is expected from any fast wind arrival late day 1 or day 2 (23-24 Aug). Flux is then likely to increase again days 3-4 (25-26 Aug) as any enhanced solar winds ease. The associated 24 hour fluence is expected to

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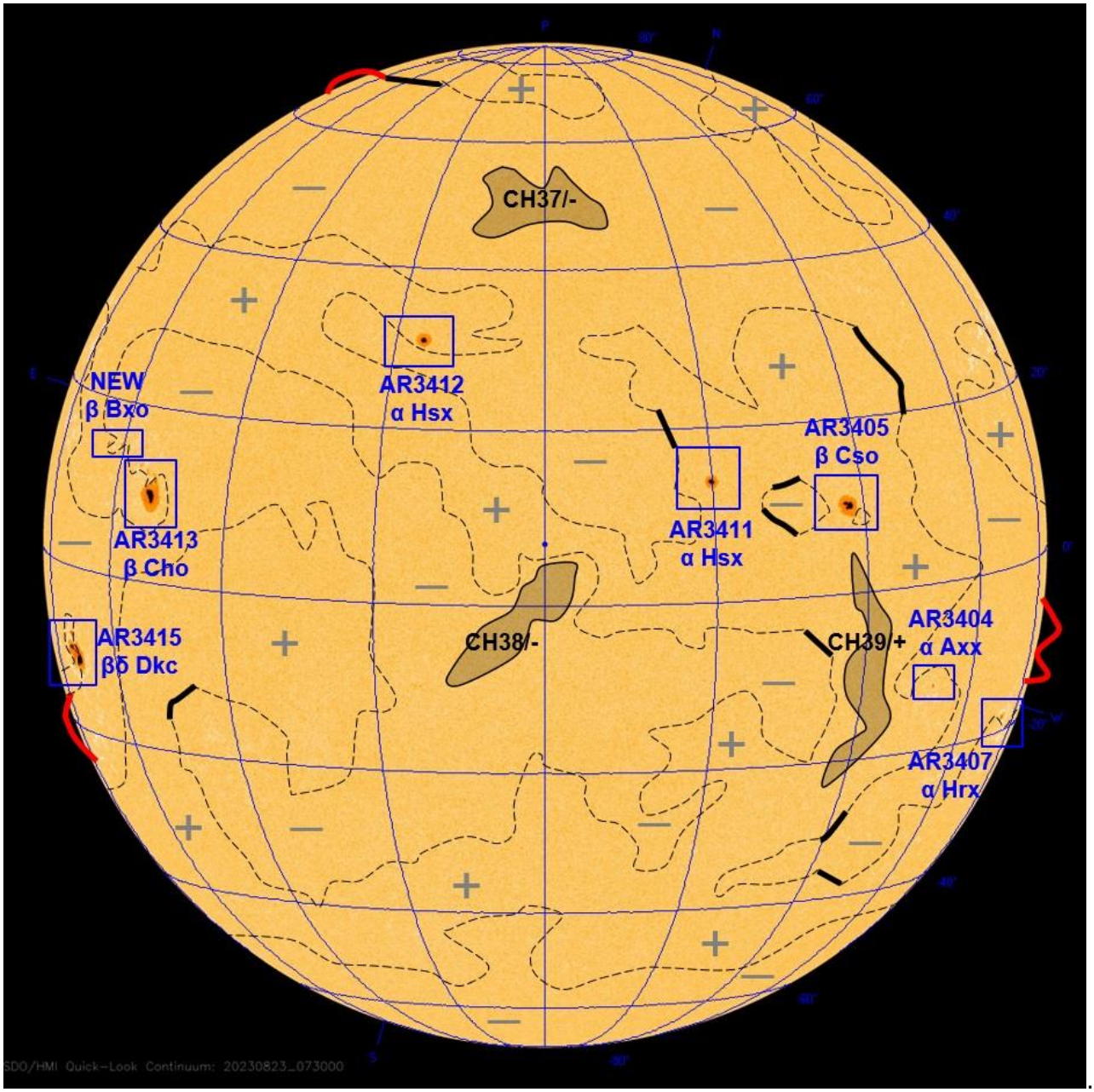
remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 23/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs. A filament eruption from 22 Aug is expected to pass just ahead, and missing. A further filament eruption on 23 Aug from the southwest disc is still under analysis. The broad coronal dimming event from the M1.1 flare of AR3405 around 22/2300 UTC has not produced an observable CME.

Solar winds are currently slightly elevated, with the most likely source of any increase in speed to be from any interaction with the fast wind of CH39/+ later day 1 or during day 2 (23-24 Aug). This is a small positive coronal hole in the southwest disc, but due to nearby bright coronal the extent of this feature is uncertain in extent, although the dimming event above did enable to brief view of the likely hole. 27-day persistence is also contaminated from a CME arrival, so despite the coronal hole being present on the previous rotation confidence is reduced. Furthermore, very little enhancement is indicated in current ENLIL modelling, however this failed to detect the recent fast wind enhancement and is not currently providing poor guidance due to this.

Overall, this gives low confidence in the forecast, however an enhancement to around 500-550 km/s is currently considered possible, most likely later day 1 or day 2 (23-24 Aug) before declining. Some further enhancement is also possible day 4 (26 Aug) due to CH38/- near centre disk.

Mainly Quiet geomagnetic activity is expected at first, with isolated Unsettled spells. This increasing to Unsettled to Active with any coronal hole HSS onset later day 1 or day 2 (23-24 Aug), with a chance of isolated G1 Minor Storms. Activity is then expected to ease back to mostly Quiet to Unsettled day 3-4 (25-26 Aug). There is a slight chance of this rising again to Unsettled to Active from any further HSS arrival later day 4 from CH38/-.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: Enlil showing only a very weak enhancement from expected CH arrival

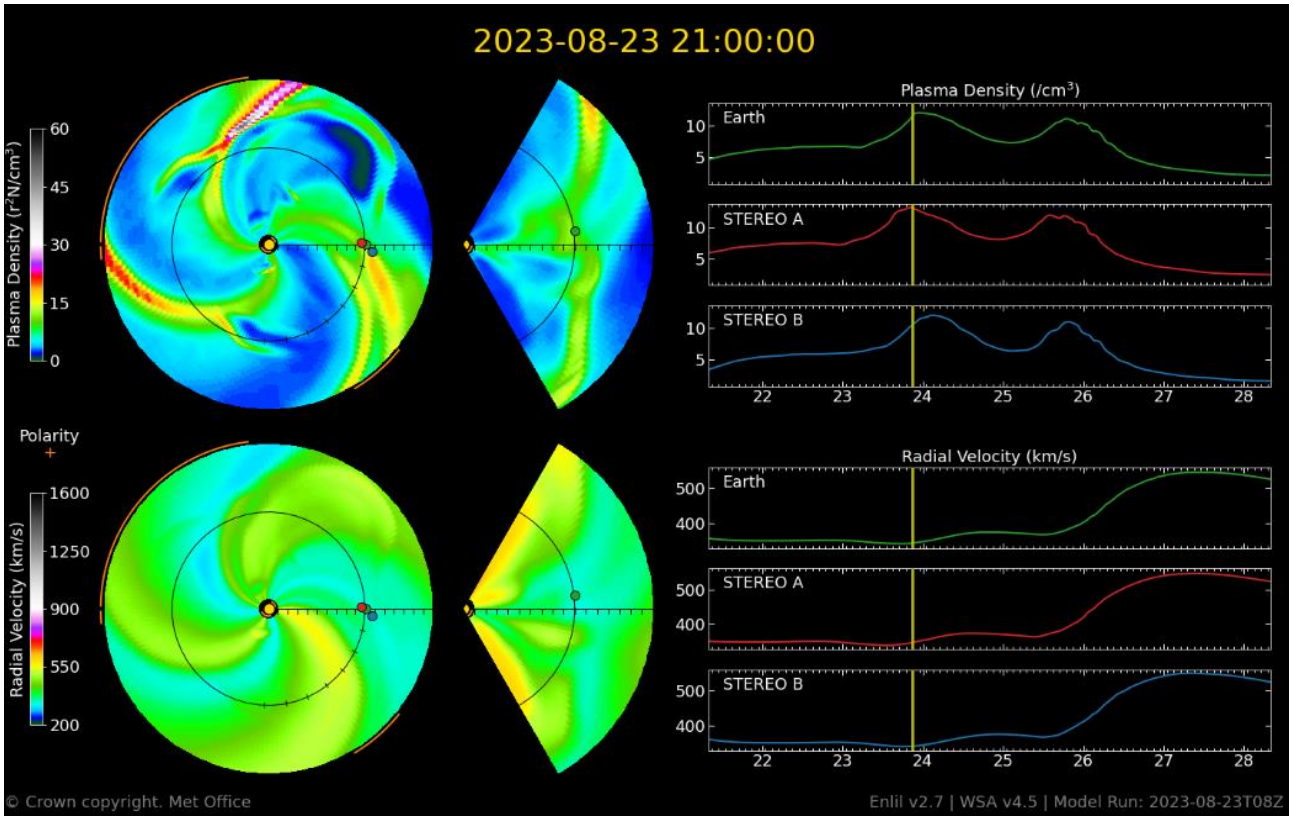
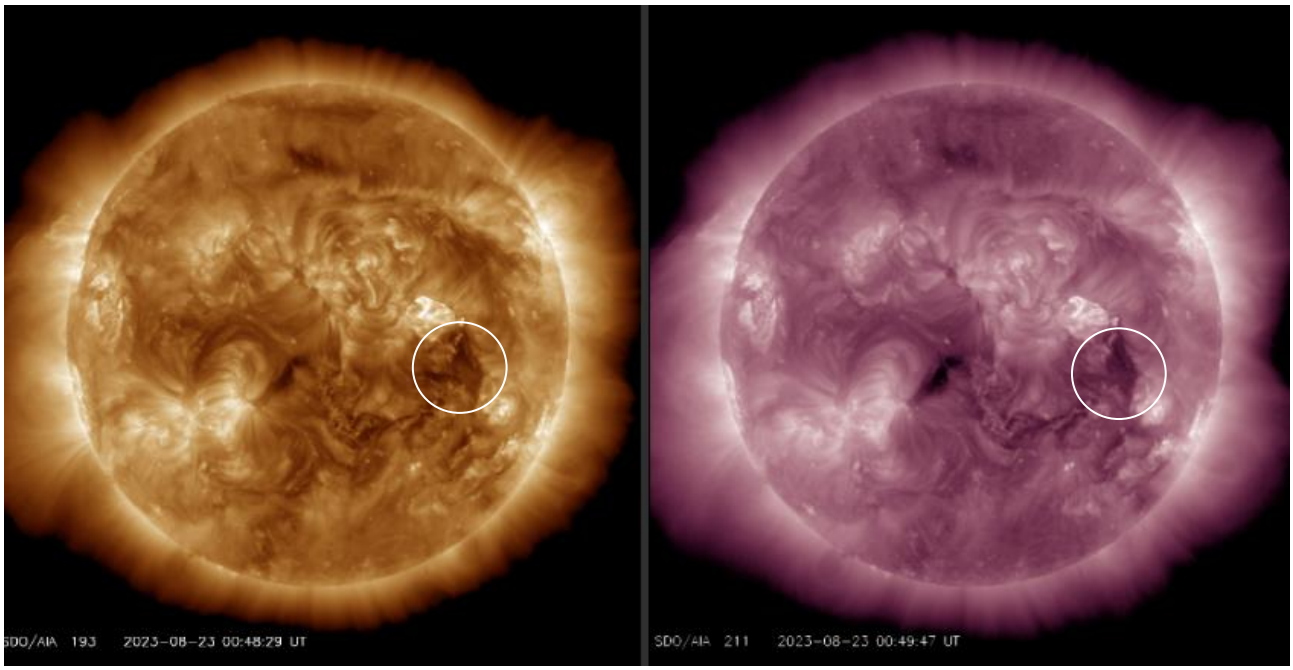


Figure 3: SDO aia-193 (left) and 211 (right) during CH dimming event, allowing CH in SW to be observed (circled).



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Radio Blackouts - X-Ray Flares:

Activity is currently Moderate due to an M1.1 flare peaking at 22/2304 UTC from AR3405 in the northwest disc. This region has since simplified to a mature unipolar spot.

The main sunspot of interest is AR3415 in the southeast. This is a modestly sized, but compact and potentially complex region, although the extent of the complexity remains difficult to accurately assess given its location close to the southeast limb. It currently appears dominated by a strong negative umbra, with following positive polarity spots contained within a single penumbra. However, some degree of foreshortening is likely occurring, and this may be leading to the apparent complexity being greater than in reality, especially given the lack of recent activity observed from the region. For now, the more complex assessment is accepted, however this may need to be reviewed as it rotates into a clearer view.

Otherwise, the sunspots on the disc are generally smaller and simpler, with the main exception being AR3413 in the northeast, which is dominated by a large leader but with small nearby opposite polarity spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	40	40
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3a: GOES-16/18 X-ray flux

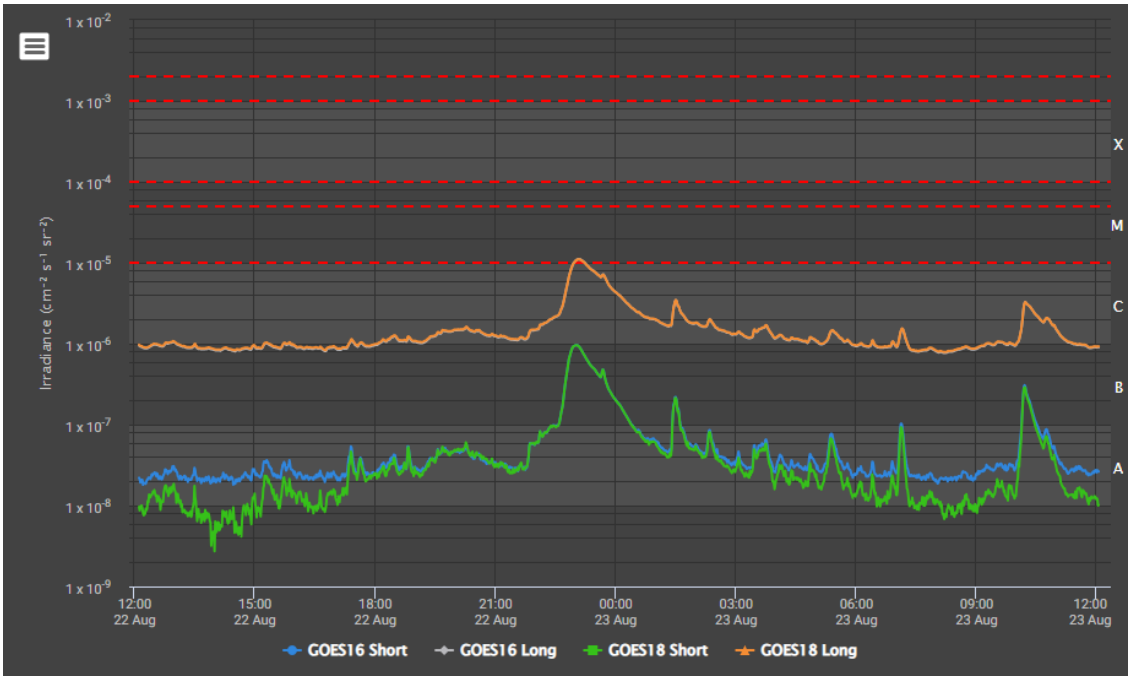

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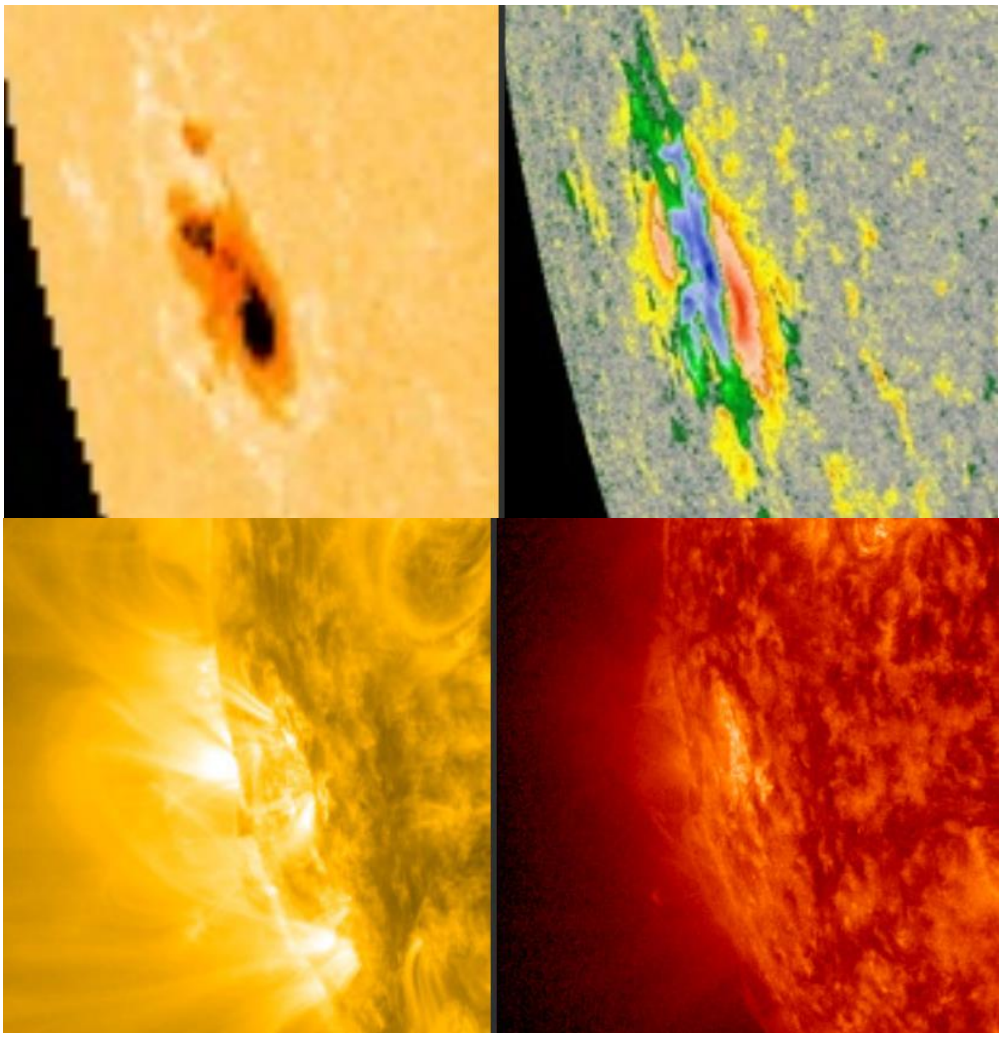
Figure 3b: SDO Hmi-intensitygram and magnetogram of AR3415 (top). Aia-171 and aia 304 (bottom)



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background levels, with the spots on the western disc currently small and simple.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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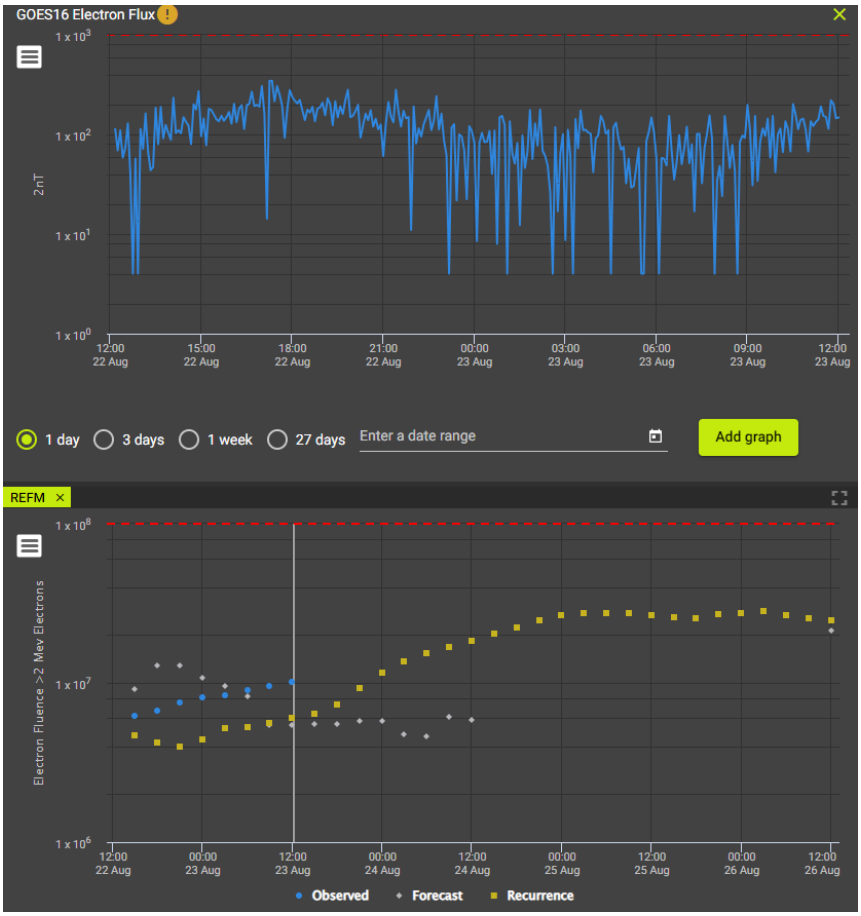
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux observed by GOES-16 is currently varying between Background and Moderate. Any HSS solar wind enhancement day 1-2 (23-24 Aug) is likely drop out observed flux to background, before increasing to Moderate, perhaps High levels days 3 and 4 (25-26 Aug), as solar winds ease.

The associated 24 hour fluence is expected to persist below the Active level to start, with no significant enhancements expected. An increasing trend is expected day 3 (25 Aug) onwards, with the risk of breaching the active level increasing but still low. MOSWOC REFM model currently looks to be providing reasonable guidance, at least until any HSS enhancement arrives.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron flux and Fluence with REFM



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